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Digital Policy Hub

Digital Policy Hub – Working Paper

Patent as a Tool for Facilitating Innovation: Lessons from Green Technology

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Key Points

- Artificial intelligence (AI)-driven technologies designed for climate-smart agriculture have the potential to enhance various stages of agricultural processes. Promoting innovation with an environmental focus has become a central objective in both national and international environmental policies.
- Intellectual property (IP) regimes, particularly patent laws, are recognized as pivotal regulatory mechanisms to drive technological advancement. Recognizing the substantive role of patents in fostering innovation, various patent-based collaborative models have been introduced to encourage the development of green technologies.
- To boost the innovation of green technologies, several national IP offices have implemented initiatives to expedite the processing of "green" patent applications. Despite the adoption of various patent-based mechanisms, the inadequacy of patent systems in incentivizing green technology is well documented and persists.
- A potential solution to capture more positive externalities associated with green technologies involves the implementation of a patent prize system, also known as a "patent reward."
- The introduction of a Patents for Humanity award across diverse jurisdictions could be a highly effective stimulus for innovating AI-powered, climate-smart agricultural technologies.

Introduction

Climate change and agriculture have an interchangeable correlation (Verschuuren 2016). This is because, on one hand, global agricultural activities significantly contribute to both greenhouse gas (GHG) emissions and sinks, and on the other hand, the globally changing climate has an observable negative impact on agricultural activities (ibid.). Taking these issues into account, the idea of climate-smart agriculture refers to "an integrated approach to managing landscapes — cropland, livestock, forests and fisheries — that addresses the interlinked challenges of food security and accelerating climate change."[1] Accordingly, it aims to simultaneously achieve three outcomes: increased productivity, enhanced resilience and reduced emissions.[2]

Due to adverse outcomes of global climate change, farmers across the globe encounter numerous obstacles, including the challenges of increased extreme weather, climate impact analysis and crop health monitoring. In this regard, AI and machine learning have recently become integral tools in climate-smart agricultural practices by addressing many of the above-mentioned difficulties. Significant advancements in deep learning have facilitated the creation of systems capable of making swift and efficient decisions in agricultural processes. AI can contribute to improved decision making for farmers, aiding in determining optimal times for planting and harvesting, as well as the appropriate application of fertilizers

1 See www.worldbank.org/en/topic/climate-smart-agriculture.

2 *Ibid.*

and irrigation. Leveraging historical weather data, machine learning models can forecast climatic conditions throughout the year. Additionally, AI can play a crucial role in analyzing crop health using drones, coupled with predictive analytics capabilities. A noteworthy development is the implementation of AI-based automated monitoring in agriculture through wireless sensor networks (Kose et al. 2022, 45).

A study shows that AI-powered technologies for climate-smart agriculture can facilitate diverse stages of agriculture such as yield prediction, disease detection, weed detection, crop quality identification and species recognition. As well, AI can also facilitate water management, soil management, monitoring peat lands and forest management (Uddin, Chowdhury and Kabir 2022). This paper aims to examine what role the current patent system can play in facilitating innovation of AI-powered, climate-smart agricultural technologies. In this context, the paper will draw upon the experiences of various collaborative patent models that have already been employed in other sectors to encourage the innovation of green technologies (Uddin and Karim 2020).

This paper will commence by exploring the intricate relationship between climate change and agriculture, emphasizing the efficacy of climate-smart agriculture in addressing this dynamic interplay. Subsequently, it will delve into how global efforts, spearheaded by the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, address the challenges faced by agriculture and the imperative for innovating climate-smart agricultural technologies. The paper will then examine the role of patents as a catalyst for innovation, drawing insights from various collaborative patent models applied in the realm of green technologies. Following this, the study will scrutinize the limitations of patents in sufficiently driving innovation in green technologies, proposing alternative patent models as viable mechanisms for fostering greater innovation in AI-powered climate-smart agricultural technologies.

The Interplay between Climate Change and Agriculture

According to the *Fifth Assessment Report* from the Third Working Group of the Intergovernmental Panel on Climate Change (IPCC), the Agriculture, Forestry, and Other Land Use sector is responsible for approximately one-quarter of anthropogenic GHG emissions (Smith et al. 2014, 823). Despite a continuous rise in global GHG emissions from the agriculture sector since 1990, this issue remained unaddressed by the UNFCCC and the Kyoto Protocol. In addition to some methodological challenges on how to include agricultural-related emissions in GHG inventories (Muldowney, Mounsey and Kinsella 2013), the lack of attention was partly attributed to political reluctance, fearing potential impacts on global food production (Angelo and Du Plesis 2016). Regulatory challenges also played a role, given the multitude of factors influencing emissions and the difficulty in measuring them at the individual firm level (Saddler and King 2008, 102). Despite the potential of the expanding carbon offset market in the agricultural sector to assist in lowering GHG emissions from agriculture (S&P Global 2022), it can be inferred that its expected impact will fall considerably short of the necessary overall GHG emission reductions.

The IPCC's *Fifth Assessment Report* suggests that climate change with a local temperature increase of 2°C or more, will negatively impact the production of tropical regions' main crops such as rice, wheat, maize and so on (Porter et al. 2014, 488). The IPCC report finds that global warming has already had a negative impact on maize and wheat production in many regions (Campbell 2015). Accordingly, it is asserted that the Paris Agreement's goal of 1.5°C is insufficient to prevent a net loss of agricultural production (ibid.). It is predicted that the changed climate will require more than 40 percent increased irrigation across the globe (Porter et al. 2014, 251). In many regions, too much rainfall will also impact agricultural productivity. Hence, numerous adaptation measures will be essential in the agriculture sector.

The situation is expected to become more critical in the future as the world will need continued growth in agricultural production to feed the growing global population (Campbell et al. 2011, 1). The interfaces that exist among agriculture, climate change and future demand for food for an increased global population suggest three specific propositions: First, the agriculture sector must find proper adaptation measures to cope with the adversities posed by the changing climate system. Second, the agriculture sector must be supported by a wide range of mitigation mechanisms so that GHG emissions from this sector are significantly reduced. Third, the global agriculture sector must find a way of enhancing its productivity while limiting further GHG emissions. This leads us to a realm of "climate-smart agricultural practices," which refer to a strategy for addressing the climate change and food security challenges by way of "sustainably increasing productivity and incomes, adapting to climate change and reducing greenhouse gas emissions where possible."[3] However, all climate-smart agricultural practices applied in all locations may not produce these "triple wins."[4]

Global Climate Regime and Innovation of Climate-Smart Agricultural Technologies

While there is a single mention of agriculture in one of the negotiating texts of the Paris Agreement, the ultimate agreement omits any reference to agriculture altogether. Likewise, "food production" is recurrently introduced in the negotiation texts as a constraining element for mitigation-related measures, mirroring article 2 of the UNFCCC. However, in the final version of the agreement, such a reference appears only once.[5]

Given the interconnected impacts of climate change and agriculture, it is disheartening that the Paris Agreement has not afforded specific attention to the agricultural sector. However, the lack of direct reference to agriculture does not mean that the issue cannot be dealt with under the Paris Agreement. This is because both adaptation and mitigation-related provisions of agreement apply to the global agriculture sector.[6]

3 See www.fao.org/climate-smart-agriculture/overview/en/.

4 *Ibid*.

5 *Paris Agreement*, 12 December 2015, 3156 UNTS 79 art 2 (entered into force 4 November 2016).

6 *Ibid*, art 2, preamble at paras 9, 11.

While the term “agriculture” is missing in the texts of the Paris Agreement, it is understandable that the agreement does not contain any notion of climate-smart agriculture. However, the mere absence of reference to this specific term does not mean that the issue is beyond the scope of the agreement. Instead, it is covered by other provisions where the necessity of development and deployment of relevant scientific knowledge and technology has been expressly mentioned.[7]

The Paris Agreement also endorses the Technology Mechanism that consists of two bodies: the Technology Executive Committee and the Climate Technology Centre and Network established by the Conference of the Parties in 2010.[8] In 2022, the twenty-seventh Conference of the Parties to the UNFCCC launched a Joint Work Programme of the UNFCCC Technology Mechanism (UNFCCC 2022).

Patent as a Facilitator of Innovation: Insights from Green Technology

Fostering innovation with an environmental focus has emerged as a primary goal in both national and international environmental policies. IP regimes, particularly patent laws, are deemed to play a pivotal role as regulatory mechanisms driving technological advancement (Dechezleprêtre 2013).

The conventional argument supporting IP protection, as articulated in the influential works of K. J. Arrow (1962), William Nordhaus (1969) and Paul M. Romer (1990), is familiar: innovation involves generating knowledge, but since knowledge is inherently non-rivalrous, even when integrated into new products or technologies, it leads to market failure and insufficient incentives for innovation (Arrow 1962).

The inherent non-rivalrous nature of knowledge means that the quantity of knowledge accessible to any individual does not diminish when others use it. The consumption of knowledge does not necessitate additional resources beyond those allocated to its initial production. Once created, it can be utilized by others without diminishing its value. This non-rivalrous characteristic, a trait of public goods, stands in contrast to the competitive nature of private goods, where one’s individual consumption reduces the overall availability of others. Additionally, knowledge possesses a non-excludable trait, signifying that once produced, others cannot be prevented from benefiting and, consequently, everyone can use it unless exclusive legal rights protect it (Encaoua, Guellec and Martinez 2006, 1425).

In this context, the prevailing argument posits that the presence of perfect competition in the product market impedes innovators from recovering their innovation costs. This is especially evident when the creation of knowledge entails a fixed and indivisible expenditure, such as research and development (R&D) investment, and the goods and services embodying this knowledge can be produced and distributed at a

7 *Ibid*, arts 7(5), 10(1)-(2).

8 See https://unfccc.int/ttclear/support/technology-mechanism.html.

minimal marginal cost. As a result, public intervention becomes essential to restore private incentives for engaging in R&D activities and producing socially valuable knowledge. The non-rivalrous and non-excludable characteristics of knowledge play a role in market failure, prompting the need for corrective measures (ibid.).

Traditionally, patents have been regarded as a legitimate policy tool to address this market failure, serving as an *ex ante* incentive mechanism by granting the inventor exclusive rights to utilize or sell their invention. Through the imposition of legal exclusivity on knowledge utilization, society fosters upfront investment in R&D, thereby promoting the generation of knowledge and innovation (ibid.).

Given the positive role of patents in facilitating innovation as mentioned above, various patent-based collaborative models have been introduced to promote the development of green technologies. Although these collaborative models are not explicitly tailored for promoting innovation in AI-powered, climate-smart agricultural technologies, their outcomes — whether successful or unsuccessful — will prove instrumental in formulating a fitting innovation strategy for these technologies.

Evolution of Collaborative Models for Green Technology Innovation

Eco-Patent Commons

To address the increased adversities posed by climate change, in 2008, the World Business Council for Sustainable Development established the Eco-Patent Commons (Shepard 2008). It has brought together companies committed to combat climate change and facilitated sustainability through sharing their patents on green technologies or eco-friendly technologies. Participating companies and industry leaders such as IBM, Bosch, Sony and DuPont have shared a spectrum of technologies, ranging from renewable energy solutions to waste reduction and water conservation technologies (ibid.). This not-for-profit initiative provided royalty-free access to 248 patents before it was discontinued in 2016 (Contreras, Hall and Helmers 2018, 1).

In comparison with other mechanisms for sharing patents such as cross-licensing and patent pools, the Eco-Patent Commons pool was different since patent owners of the Eco-Patent Commons did not give up their patent ownership but allowed free access to their patents by third parties, including their competitors. While the Eco-Patent Commons initiative received scholarly attention in literature (Hall and Helmers 2013; Mattioli 2012; Awad 2015; Contreras 2014), it was not obvious “what benefits the commons offered to participants beyond reputational enhancement” (Contreras, Hall and Helmers 2018, 1).

One study found that the Eco-Patent Commons unfortunately did not contribute to the diffusion of green technologies (ibid., 2), and its closure in 2016 indicates that the initiative was not successful in promoting innovation of these kinds of technologies.

Green Xchange

The Green Xchange was launched in 2010 at Davos, Switzerland. The Green Xchange, based on the underlying philosophy that the open innovation system is the best way of facilitating sustainable innovation, was launched by Nike, Best Buy, Yahoo!, Creative Commons, IDEO, Mountain Equipment Co-op, nGenera, Outdoor Industry Association, salesforce.com and 2degrees (Ghafele and O'Brien 2012, 2).

The Green Xchange employs the semi-structured public licence known as the Green Xchange Public License for sharing IP rights. This licensing approach retains certain rights for the IP holder while enabling other interested parties to obtain permission to utilize the patent in their research endeavours. This licensing framework is open to all interested parties, irrespective of their affiliation with the Green Xchange community. Those interested in utilizing the technology in any form must agree to the specified licensing terms before accessing and employing the technology (ibid., 4, 7–8).

The Green Xchange model introduces three distinct licensing structures: a standard option; a standard-plus option; and a research non-exempt option. Under the standard option, Green Xchange users gain the right to employ the patented technology for both commercial and non-commercial purposes. The "standard-plus" option provides users with a licence that involves payment and/or imposes specific restrictions, such as confining the technology's use to a particular field or geographic area. The research non-exempt option assures that the IP rights holder will refrain from enforcing rights against individuals utilizing the technology for academic research or enhancing and adapting the patented technology for non-commercial purposes (Awad 2015, 6; Ghafele and O'Brien 2012; and Lane 2011).

COSIA

Canada's Oil Sands Innovation Alliance (COSIA) stands as a testament to the power of collaboration in addressing environmental challenges within the oil and gas industry. Formed in March 2012, COSIA brings together leading companies in the sector with the shared goal of advancing sustainable practices and mitigating the environmental impact of oil sands development.[9] At the core of COSIA's approach is the commitment to technology and knowledge sharing. Member companies contribute IP and research findings to a collective pool, enabling a collaborative approach to solving complex environmental problems. This open innovation model fosters an environment where advancements made by one company benefit the entire industry, promoting a more sustainable and responsible approach to resource extraction (Awad 2015, 7).

9 See https://pathwaysalliance.ca/who-we-are/our-history/.

Table 1: Comparison among Eco-Patent Commons, Green Xchange and COSIA

Criteria	Eco-Patent Commons	Green Xchange	COSIA
Core concept	The core concept involved contributing patents with potential environmental advantages to a shared pool. This pool would then be accessible, at no cost, to other contributors as well as businesses and individuals who were not part of the pool (Bowman 2009).	The core concept is to expedite and expand sustainability-driven innovation by fostering the sharing of IP assets. To achieve this objective, Green Xchange offers a standardized patent licence framework, enabling asset holders to manage the accessibility and extent of their intellectual assets for various parties.[10]	The core concept is to foster the responsible and sustainable development of Canada's oil sands, simultaneously achieving accelerated enhancements in environmental performance through collaborative actions and innovative approaches.[11]
Mode of collaboration	A pioneering not-for-profit open collaboration initiative initiated by a small consortium of industrial firms to offer "green technology" patents for widespread, royalty-free use by any third party, even competitors, in addressing environmental challenges (Contreras, Hall and Helmers 2018, 1).	This licensing strategy preserves specific rights for the IP holder, while granting other interested parties the opportunity to secure permission for using the patent in their research pursuits (Awad 2015, 6).	The COSIA model is categorized as a semi-open collaboration mechanism, involving the sharing of green patents within the alliance to address patent gridlocks in the oil sands industry. External parties seeking access to patent pledges made by COSIA members must either join the alliance or engage in negotiations to acquire licences (Awad 2015, 7).
Strength	Typically, it bestows benefits upon all third parties, irrespective of their contribution to the common pool, and usually without the need for a formal contract or payment (Contreras 2014).	It expedites innovation by eliminating the necessity for repetitive R&D efforts, thereby minimizing redundancy in the development of environmental technologies. Additionally, the shared IP cultivates an atmosphere of open innovation, motivating participants to collaboratively tackle intricate environmental challenges (Awad 2015, 7).	This model of open innovation nurtures an atmosphere in which progress achieved by one company serves to benefit the entire industry, encouraging a more sustainable and responsible approach to resource extraction (Awad 2015, 7).
Weakness	A significant factor contributing to the failure of the Eco-Patent Commons was the initiation and implementation of the idea without consulting the demand side of technology, which pertains to the potential users of the relevant technologies. Further, it has been noted that the technologies encompassed by the contributed patents were inherently not very valuable, even before their inclusion in the commons. Additionally, the Eco-Patent Commons lacked the capability to track patent utilization (Contreras, Hall and Helmers 2018, 16–17).	The impediment to actualizing the Green Xchange model stems from a deficiency in genuine dedication to the collaborative sharing of innovative ideas among partners. Besides, Green Xchange members prioritized accessing the knowledge pool and forging relationships over actively fostering the advancement of innovations in green technology (Awad 2015, 7).	It is classified as a semi-open collaboration mechanism, encompassing the sharing of green patents within the alliance to tackle patent gridlocks in the oil sands industry. It means in order to access patent pledges made by COSIA members, external parties must either become part of the alliance or engage in negotiations to obtain licences (Awad 2015, 7).
Impact on innovation and transfer of green technology	A study revealed that, regrettably, the Eco-Patent Commons did not contribute to the innovation and widespread adoption of green technologies. The closure of the initiative in 2016 signifies its lack of success in fostering innovation in these specific types of technologies (Contreras, Hall and Helmers 2018).	Despite initially garnering promising responses, the Green Xchange initiative has not succeeded in meeting its initial objectives and, as a result, it has been unable to play a significant role in the innovation and dissemination of green technology (Ghafele and O'Brien 2012; Awad 2015, 7).	COSIA has not filed any patents in Canada or the United States under the designation COSIA. Nonetheless, individual members of COSIA may be involved in submitting patents under their respective corporate names (Awad 2015, 7).

Source: Author.

10 See https://web.archive.org/web/20110507053607/http:/www.greenxchange.cc/info/about.

11 See https://context.capp.ca/energy-matters/2018/em-og101-what-is-cosia/.

Fast-Track Green Patenting

In addition to the above-described collaborative models to foster innovation of green technologies, national IP offices have implemented initiatives to expedite the processing of green patent applications. The inaugural program was instituted by the United Kingdom in May 2009, with Australia, Israel, Japan, the Republic of Korea and the United States following suit in the same year (Dechezleprêtre 2013). Subsequently, Canada (March 2011) and Brazil and China (2012) introduced comparable programs. These initiatives aim to significantly reduce the time required to secure a patent, condensing the timeline from several years to just a few months (ibid.).

Empirical data indicates that expedited programs significantly shorten the examination process, reducing the time from the initial application to patent approval by 42 percent to 75 percent, depending on the patent office, compared to patents undergoing the standard examination procedure (ibid., viii).

A study conducted in 2013 found that a minor fraction of green patents opted for expedited examination, but a notable disparity among patent offices existed. The figures vary, with less than one percent of green patents in Australia to more than 20 percent in the United Kingdom. Canada, Japan and Korea exhibited very low participation rates (less than two percent of green patents), while the rates were considerably higher in the United States (eight percent) and Israel (13 percent) (ibid., 19).

Nevertheless, there are drawbacks to expediting the patent approval process. First, the accelerated examination may impose additional costs on patent applicants, particularly when they are obligated to conduct a search report on prior art (any evidence that the proposed invention is already known) (for example, at the Japan Patent Office) and submit comments that might have implications in litigation (ibid.).

Academics have acknowledged the significance of fast-track programs in accelerating the innovation of clean and sustainable technologies. They have suggested the harmonization of these programs to enhance eligibility across jurisdictions, aiming to simplify and streamline participation (Lane 2012). Harmonization would establish a uniform set of rules applicable to each national patent office, eliminating the need to comply with various iterations and easing the burden on applicants, especially those with an international presence across multiple jurisdictions (Ebrahim 2020, 11).

In the current fast-track program scenario, it can be observed that the program has the potential to promote the innovation of AI-powered, climate-smart agricultural technologies if rules and regulations governing fast-track programs across diverse jurisdictions are appropriately harmonized.

Limitations of Patents in Adequately Motivating Green Technology Innovation

Despite the adoption of the various patent-based mechanisms discussed above, the inadequacy of patent systems in incentivizing green technology is well documented (ibid., 15). This deficiency stems partly from the inherent market failure associated with inventions that address "common pool" issues (Adler 2011), such as the reduction of GHGs. The absence of a direct economic incentive to mitigate GHGs results in a market failure to encourage innovation effectively (ibid., 4). The patent's value is largely contingent on market demand for the underlying technology, leading to insufficient incentives in the absence of such demand (Hemel and Ouellette 2019).

Even when a market exists, the patent system falls short in providing proper incentives for green technologies, primarily due to positive externalities (Tur-Sinai 2018). Positive externalities occur when a portion of the benefits generated by a technology spill over (Burk and Lemley 2003, 1587) to third parties (Tur-Sinai 2018), meaning not all the advantages are internalized by the originating business (Desch 2023, 636). In the decision-making process of investing in a specific green technology, a profit-maximizing business is likely to concentrate on the technology's direct costs and benefits, neglecting the additional benefits extended to third parties (Tur-Sinai 2018).

As a consequence, the investment falls short of optimization because the true worth of the technology's benefits — both commercial and social — was not adequately taken into account (ibid.). When the market fails to encompass the social value associated with a particular technology, it is improbable that the technology will attract an optimal level of investment commensurate with its actual value. Consequently, the patent's value for the technology will also be less than optimal (ibid.).

Alternative Patent Models for Fostering Innovation

Patent Reward System

One potential solution to address the above-noted positive externalities involves the implementation of a patent prize system, also referred to as a "patent reward" (Mandel 2005). In this approach, a reward — often in the form of a monetary prize — is granted to the first individual who fulfills the predetermined criteria set by the government (Adler 2011, 12–13). Comparable to traditional patent systems, inventors "in a pure prize system" (Hemel and Ouellette 2019, 560) bear both the costs of development and the associated risks of potential failure (ibid., 560–61). The key distinction between patents and prizes, particularly in the context of incentivizing innovation, lies in how their values are determined (ibid.). While market forces establish the value of a patent, a non-market entity, such as the government, determines the value of a prize (ibid.).

Substantial scholarly attention has been devoted to devising accurate methods for assessing the value of prizes (Abramowicz 2003). These methods include compensation based on an inventor's anticipated profit (Mandel 2005), analysis of sales data (Shavell and Van Ypersele 2001), utilization of auction processes (Kremer 1998), and a combination of private and government estimates (Hemel and Ouellette 2019, 574).

Irrespective of the selected approach, the primary advantage of any prize system lies in the theoretical capacity of a non-market entity to consider not only the market value of a technology but also its social value (ibid., 574–75). Some proposed prize systems suggest that inventors should surrender their patent rights to the government in exchange for the prize (Mandel 2005), although this is not a mandatory feature of every prize system (Hemel and Ouellette 2013, 316). Moreover, both patents and prizes offer flexibility in terms of their financial structure, allowing for payment in either a lump sum or incremental installments over time (Hemel and Ouellette 2019, 560).

Prizes present numerous benefits compared to patent systems. As mentioned earlier, prizes are not strictly bound by market demand, allowing them to internalize positive externalities in ways that patents cannot (Tur-Sinai 2018). For instance, the market might neglect the social value of technologies with substantial positive externalities, while a prize established by the government can incorporate and recognize such value (Hemel and Ouellette 2019, 555). Moreover, prizes hold the potential to address inefficiencies arising from companies diverting resources to invent around competitors' patents (Mandel 2005, 65). Additionally, they can diminish licensing transaction costs, thereby lowering the overall risk and expenses linked to inefficient "patent thickets" (Shapiro 2001, 119).

Given the concerns mentioned, the patent reward system may be considered the most appropriate tool for fostering innovation in AI-powered, climate-smart agricultural technologies. This is because these technologies often carry social and environmental value, aspects that may not be adequately valued by typical market forces. If innovators agree to surrender their patent rights in exchange for the prize, arguably the UNFCCC Technology Mechanism may also consider buying these patent rights and creating an open-source pool for the same.

Patents for Humanity Award

The Patents for Humanity award stands out as a successful patent prize system, as evidenced by its achievements.[12] Initiated by the United States Patent and Trademark Office (USPTO), it is characterized as an "awards competition recognizing innovators who use game-changing technology to meet global humanitarian challenges." In the realm of green technology, eligible invention categories encompass "sanitation," which involves innovations addressing clean water, waste treatment, air pollution and toxic substances, and "household energy," which pertains to technologies supplying power to "energy-poor homes and communities."[13] The program was initially

12 See www.uspto.gov/ip-policy/patent-policy/patents-humanity; www.uspto.gov/ip-policy/patent-policy/patents-humanity/2020-award-recipients; www.uspto.gov/ip-policy/patent-policy/patents-humanity/2018-award-recipients; www.uspto.gov/ip-policy/patent-policy/patents-humanity/2016-award-recipients; and www.uspto.gov/ip-policy/patent-policy/patents-humanity/2015-award-recipients.

13 *Ibid*.

introduced as a pilot in 2012, and from 2012 to 2020, 36 inventors were honoured with the Patents for Humanity award, while 19 received honourable mentions.[14]

Applications undergo evaluation based on their demonstrated positive real-world impacts on humanitarian issues, along with the degree to which applicants have shared their technologies with other humanitarian researchers, especially those working in areas lacking commercial application (Kim 2020). Recipients of the Patents for Humanity award not only receive public recognition but also an acceleration certificate that can be used to expedite the processing of a single matter in the inventor's portfolio or accelerate specific post-grant proceedings before the USPTO.[15] These certificates are transferable, allowing winners to exchange them for compensation or transfer them to a third party.[16] This transferability partially shifts the valuation mechanism back to the market, sidestepping the complexities of the government determining the monetary value of the invention (Sampson 2021). Importantly, the Patents for Humanity award serves as an additional incentive for innovation by offering publicity benefits to successful inventors (ibid.). It is noteworthy that this award is specifically geared toward inventions that are either in the process of patent approval or have already been patented.[17]

Arguably, the introduction of Patents for Humanity awards across diverse jurisdictions could be a very effective stimulating agent for the innovation of AI-powered, climate-smart agricultural technologies. Since climate change is considered as a "common concern of humankind," any AI-based, climate-smart agricultural technologies will reasonably be eligible for the Patents for Humanity award.

Conclusion

This study identifies various collaborative patent models, such as the Eco-Patent Commons, Green Xchange and COSIA, as options available for fostering innovation in AI-powered, climate-smart agricultural technologies. Each model comes with its own set of pros and cons. Considering the advantages and disadvantages of these existing models, the study suggests that if a model, such as the Eco-Patent Commons, is introduced to stimulate the innovation of AI-powered, climate-smart agricultural technologies, it should be designed to resolve the weaknesses experienced by the previously existing Eco-Patent Commons. Importantly, consulting with the demand side of the technologies from the outset is deemed essential.

Additionally, the study notes that while Green Xchange fell short of its main goals, it generated intriguing ideas applicable to the establishment of any similar mechanism aimed at fostering innovation in AI-powered, climate-smart agricultural technologies. For instance, the three distinct licensing structures — standard, standard-plus and research non-exempt — could prove beneficial in increasing the participation of suggested initiatives.

14 *Ibid.*

15 *Patents for Humanity Program*, 79 Fed Reg 18670 (2014).

16 *Patents for Humanity Improvement Act*, Pub L No 116-316, 134 Stat 5065 (2021).

17 *Patents for Humanity Program, supra* note 15.

Further, the study finds that the COSIA model could serve as an inspiration for investors who prefer a semi-open collaboration method and hesitate to share their innovation methodology or patent rights with anyone outside the pool.

In addition to collaborative patent models, this study evaluates the suitability of the fast-track green patent program for fostering innovation in AI-powered climate-smart agricultural technologies. In this regard, the paper considers that the program has the potential to promote innovation if rules and regulations governing fast-track programs across diverse jurisdictions are appropriately harmonized.

Finally, the study suggests two alternative patent models, namely the "patent reward" and "Patents for Humanity award," as the most suitable options for stimulating innovation in AI-powered, climate-smart agricultural technologies. The patent reward system is highlighted as one of the most appropriate tools for fostering innovation in these technologies, as the social and environmental value of these technologies are often overlooked under the usual patent system. If innovators agree to surrender their patent rights in exchange for the prize, the study suggests that the UNFCCC Technology Mechanism may also consider buying these patent rights and creating an open-source pool for this kind of technology. The introduction of Patents for Humanity awards across diverse jurisdictions may also be considered a highly effective stimulating factor for innovation in AI-powered, climate-smart agricultural technologies, given that climate change is deemed a "common concern of humankind,"[18] making any AI-based, climate-smart agricultural technologies reasonably eligible for the Patents for Humanity award.

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18 *United Nations Framework Convention on Climate Change*, 9 May 1992, 1771 UNTS 107 (entered into force 21 March 1994).

Works Cited

Abramowicz, Michael B. 2003. “Perfecting Patent Prizes.” *Vanderbilt Law Review* 56 (1): 115–236.

Adler, Jonathan H. 2011. “Eyes on a Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization.” *Harvard Environmental Law Review* 35 (1). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1576699.

Angelo, Mary Jane and Anél Du Plesis, eds. 2016. *Research Handbook on Climate Change and Agricultural Law*. Cheltenham, UK: Edward Elgar. https://doi.org/10.4337/9781784710644.

Arrow, K. J. 1962. “Economic welfare and the allocation of resources for invention.” In *Readings in Industrial Economics*, edited by C. K. Rowley, 219–36. London, UK: Palgrave.

Awad, Bassem. 2015. *Global Patent Pledges: A Collaborative Mechanism for Climate Change Technology*. CIGI Paper No. 81. Waterloo, ON: CIGI. www.cigionline.org/publications/global-patent-pledges-collaborative-mechanism-climate-change-technology/.

Bowman, Jo. 2009. “The Eco-Patent Commons: Caring through sharing.” *WIPO Magazine*, June. www.wipo.int/wipo_magazine/en/2009/03/article_0004.html.

Burk, Dan L. and Mark A. Lemley. 2003. “Policy Levers in Patent Law.” *Virginia Law Review* 89 (7): 1575–1696.

Campbell, Bruce. 2015. “Climate Change: Half a Degree Will Make a World of Difference for the Food We Eat.” *Huffpost* (blog), December 9. www.huffpost.com/entry/climate-change-half-a-deg_b_8756428.

Campbell, Bruce, Wendy Mann, Ricardo Meléndez-Ortiz, Charlotte Streck and Timm Tennigkeit. 2011. *Agriculture and Climate Change: A Scoping Report*. Meridian Institute. July.

Contreras, Jorge L. 2014. “Constructing the Genome Commons.” In *Governing Knowledge Commons*, edited by Michael J. Madison, Katherine J. Strandburg and Brett M. Frischmann, 99–136. Oxford, UK: Oxford University Press.

Contreras, Jorge L., Bronwyn H. Hall and Christian Helmers. 2018. *Assessing the Effectiveness of the Eco-Patent Commons: A Post-mortem Analysis*. CIGI Paper No. 161. Waterloo, ON: CIGI. www.cigionline.org/publications/assessing-effectiveness-eco-patent-commons-post-mortem-analysis/.

Dechezleprêtre, Antoine. 2013. *Fast-tracking Green Patent Applications: An Empirical Analysis*. ICTSD Programme on Innovation, Technology and Intellectual Property Issue Paper No. 37. Geneva, Switzerland: International Centre for Trade and Sustainable Development.

Desch, Benjamin. 2023. “Fast-Tracks and Prizes: A Multi-Pronged Approach to Incentivizing Green Technology Innovation.” *Washington Law Review* 98: 625–58. https://digitalcommons.law.uw.edu/wlr/vol98/iss2/8.

Ebrahim, Tabrez Y. 2020. “Clean and Sustainable Technology Innovation.” *Current Opinion in Environmental Sustainability* 45: 113–17. https://lawcommons.lclark.edu/faculty_articles/178.

Encaoua, David, Dominique Guellec and Catalina Martínez. 2006. “Patent systems for encouraging innovation: Lessons from economic analysis.” *Research Policy* 35 (9): 1423–40.

Ghafele, Roya and Robert D. O’Brien. 2012. “Open Innovation for Sustainability: Lessons from the Green Xchange Experience.” Policy Brief No. 13. Geneva, Switzerland: International Centre for Trade and Sustainable Development.

Hall, Bronwyn H. and Christian Helmers. 2013. “Innovation and diffusion of clean/green technology: Can patent commons help?” *Journal of Environmental Economics and Management* 66 (1): 33–51. https://doi.org/10.1016/j.jeem.2012.12.008.

Hemel, Daniel J. and Lisa Ouellette. 2013. “Beyond the Patents-Prizes Debate.” *Texas Law Review* 92 (303): 327–28.

– – –. 2019. “Innovation Policy Pluralism.” *Yale Law Journal* 128 (3): 544–614.

Kim, Edward. 2020. “Patents for Humanity.” Harrity. https://harrityllp.com/patents-for-humanity/.

Kose, Utku, V. B. Surya Prasath, M. Rubaiyat Hossain Mondal, Prajoy Podder and Subrato Bharati, eds. 2022. *Artificial Intelligence and Smart Agriculture Technology*. London, UK: Taylor & Francis Group.

Kremer, Michael R. 1998. “Patent Buyouts: A Mechanism for Encouraging Innovation.” *Quarterly Journal of Economics* 113 (4): 1137–67. https://academic.oup.com/qje/article-abstract/113/4/1137/1916997?.

Lane, Eric. 2011. *Clean Tech Intellectual Property: Eco-marks, Green Patents, and Green Innovation*. Oxford, UK: Oxford University Press.

– – –. 2012. “Building the Global Green Patent Highway: A Proposal for International Harmonization of Green Technology Fast Track Programs.” *Berkeley Technology Law Journal* 27 (3). https://ssrn.com/abstract=2000919.

Mandel, Gregory N. 2005. “Promoting Environmental Innovation with Intellectual Property Innovation: A New Basis for Patent Rewards.” *Temple Journal of Science, Technology & Environmental Law* (24) (1): 51–69.

Mattioli, Michael. 2012. “Communities of Innovation.” *Northwestern University Law Review* 106 (1): 103–55.

Muldowney, J., J. Mounsey and L. Kinsella. 2013. “Agriculture in the climate change negotiations; ensuring that food production is not threatened.” *Animal* 7 (2): 206–11. https://doi.org/10.1017/S175173111300089X.

Nordhaus, William D. 1969. *Invention, Growth, and Welfare: A Theoretical Treatment of Technological Change*. Cambridge, MA: MIT Press.

Porter, John R., Liyong Xie, Andrew J. Challinor, Kevern Cochrane, S. Mark Howden, Muhammad Mohsin Iqbal, David B. Lobell and Maria I. Travasso. 2014. “Food Security and Food Production Systems.” In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by Christopher B. Field, Vicente R. Barros, David Jon Dokken, Katharine J. Mach, Michael D. Mastrandrea, T. Eren Bilir, Monalisa Chatterjee, Kristie L. Ebi, Yuka Otsuki Estrada, Robert C. Genova, Betelhem Girma, Eric S. Kissel, Andrew N. Levy, Sandy MacCracken, Patricia R. Mastrandrea and Leslie L. White, 485–533. New York, NY: Cambridge University Press.

Romer, Paul M. 1990. “Endogenous Technical Change.” *Journal of Political Economy* 94 (5): 71–102.

S&P Global. 2022. “Carbon Farming: Opportunities for agriculture and farmers to gain from decarbonization.” *ESG & Climate Research* 39. www.spglobal.com/esg/insights/carbon_farming_investment_research_report.pdf.

Saddler, Hugh and Helen King. 2008. “Agriculture and Emissions Trading: The impossible dream?” Discussion Paper No. 102. October. Canberra, Australia: The Australia Institute.

Sampson, Elizabeth. 2021. “Patents for Humanity: The USPTO Recognizes Innovation Relating to COVID-19.” *Global IP & Technology Law Blog*, July 22. www.iptechblog.com/2021/07/patents-for-humanity-the-uspto-recognizes-innovation-relating-to-covid-19/.

Shapiro, Carl. 2001. “Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting.” In *Innovation Policy and the Economy*, vol. 1, edited by Adam B. Jaffe, Josh Lerner and Scott Stern, 119–50. Cambridge, MA: MIT Press.

Shavell, Steven and Tanguy Van Ypersele. 2001. “Rewards Versus Intellectual Property Rights.” *Journal of Law and Economics* 44 (2): 525–47.

Shepard, Jeff. 2008. “‘Eco-Patent Commons’ Coalition To Place Environmentally-Friendly Patents In Public Domain.” EE Power, January 20. https://eepower.com/news/eco-patent-commons-coalition-to-place-environmentally-friendly-patents-in-public-domain/#.

Smith, Pete, Helal Ahammad, Harry Clark, Hongmin Dong, Elnour A. Elsiddig, Helmut Haberl, Richard Harper, Joanna House, Mostafa Jafari, Omar Masera, Cheikh Mbow, Nijavalli H. Ravindranath, Charles W. Rice, Carmenza Robledo Abad, Anna Romanovskaya, Frank Sperling and Francesco N. Tubiello. 2014. “Agriculture, Forestry and Other Land Use (AFLOU).” In *Climate Change 2014: Mitigation of Climate Change*, 811–922. IPCC Working Group III Contribution to AR5. New York, NY: Cambridge University Press.

Tur-Sinai, Ofer. 2018. “Patents and Climate Change: A Skeptic’s View.” *Environmental Law* 48 (1): 233–34.

Uddin, Mahatab and Saiful Karim. 2020. “International Law and South-South Cooperation for Innovation and Transfer of Green Technologies.” *George Washington International Law Review* 52 (3): 355–91.

Uddin, Mahatab, Ataharul Chowdhury and Ashad Kabir. 2022. “Legal and ethical aspects of deploying artificial intelligence in climate-smart agriculture.” *AI and Society* (April). https://doi.org/10.1007/s00146-022-01421-2.

UNFCCC. 2022. “Joint Work Programme of the UNFCCC Technology Mechanism Launched at COP27.” Press release, November 15. https://unfccc.int/news/joint-work-programme-of-the-unfccc-technology-mechanism-launched-at-cop27.

Verschuuren, Jonathan. 2016. “The Paris Agreement on Climate Change: Agriculture and Food Security.” *European Journal of Risk Regulation* 7: 54–7.

– – –. 2017. “Climate change and agriculture under the United Nations Framework Convention on climate change and related documents.” In *Research Handbook on Climate Change and Agricultural Law*, edited by Mary Jane Angelo and Anél Du Plesis, 21–46. Cheltenham, UK: Edward Elgar. https://doi.org/10.4337/9781784710644.